

Permian Insects from the Beaufort Group of Natal, South Africa

by

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ABSTRACT

An account is given of the fossil insects of the Beaufort Group (Late Permian) investigated since the last publication by Riek (1976). The Odonata and Trichoptera are reported for the first time; specimens are assigned to three known genera not previously recorded in South Africa; eight new species are described, two in new genera. The new taxa are as follows. Megasecoptera: *Karoothymen minutus* sp. n.; Homoptera: *Permocicada thompsoni* sp. n., *Stenotegmocicada triclades* gen. n. et sp. n., *Afrostenivicia rediae* gen. n. et sp. n.; Mecoptera: *Calliethira granthami* sp. n., *Prochoristella balgowanensis* and *P. bulwerensis* spp. n., *Neochoristella goodalli* sp. n. Several previously described taxa are recorded from additional sites.

INTRODUCTION

Most of the new material discussed below came from two new sites - Mount West, near Mooi River, and Balgowan, near Lidgetton - or from Bulwer and Lidgetton, previous type localities. All the sites lie in the Beaufort Group of the Karoo Sequence, of Upper Permian age, with the uppermost site, Bulwer, at the Permian/Triassic boundary. The locations of the sites are indicated in Van Dijk (1997, see Erratum [1998]), where the upper age limit is also discussed. The sediments of the Beaufort Group, deposited in fluvial and lacustrine environments, consist of shales, with subordinate cross-bedded sandstones and occasional thin coal seams. The insects, and associated plant fossils, occur in minor upward-coarsening sequences, in what are interpreted as bays between the distributaries of deltas, the Bay Facies (pp. 230–235) of Van Dijk, Hobday & Tankard (1978). The layers containing the insect fossils and associated plant fossils are interpreted as having been produced by over-bank spill, while the overlying upward-coarsening sediments represent overriding distributaries which bury the bay deposits. Anderson & Anderson (1985) give information on the palaeoflora and other aspects of collecting sites, while the Lidgetton site has been the subject of a separate study (Van Dijk, 1981).

Dr Edgar Riek prepared notes on all the Beaufort insect material during a visit to South Africa, and presented them to the Natal Museum before retiring from investigations in this field. These notes have served as a framework for this study. However, reworking of the material places the responsibility of any short-comings on our shoulders.

METHODS

Colour photographs of pertinent specimens were taken, usually several of each specimen, part and counterpart (if available), with low angle lighting (circa 10°) from different angles, sometimes with reversed lighting to permit combining prints of part and counterpart or to produce correct relief. Images were laterally inverted where necessary to produce apex to the right. Outlines of wings and major features of venations were obtained as tracings on transparent overlay sheets from colour prints of A4 or A5 size (magnifications 5x to 48x), or were drawn on black and white photographs of similar size followed by bleaching of the images. Details were filled in by viewing the specimens and often also photographs of the specimen, taken with lighting from various angles. Stereo pairs of photographs were sometimes used to produce exaggerated relief when viewed in a stereoscope, for instance to help elucidation of venation where wings overlapped or were buckled. The tracings or drawings were then labelled without reference to literature; literature was then consulted, including general works such as Handlirsch (1906–8), Rohdendorf *et al.* (1961), Rohdendorf ed. (1991), Kukalová-Peck (1991) and Carpenter (1992), and the original descriptions of appropriate genera. Nomenclature followed that of the original descriptions. Notes made by Edgar Riek were compared with our observations.

Formal descriptions of new species were prepared only from specimens which could either be placed with reasonable confidence in existing genera, or which were good enough to warrant description of new genera. Other distinctive specimens are noted and figured, and nearest family (three) or genus (twelve specimens) indicated. Since further collection at the provenance of all but one of them is still possible, their description is deferred.

INVENTORY OF UPPER PERMIAN BEAUFORT GROUP FOSSIL INSECTS

The higher categories are, as far as possible, those of the latest Zoological Record organised as in Carpenter (1992).

Megasecoptera

Scytohymenidae

Karoohymen delicatulus Riek, 1976

Carpenter (1992) synonymises genus with *Asthenohymen* Tillyard, family Asthenohymenidae, Order Diaphanopteroidea.

K. minutus sp.n from Mooi River

Figs 1 & 2

Odonata

Recorded from the Beaufort Group and the Permian of South Africa for the first time.

Two specimens from Balgowan, one from Far End (Mooi River)

Figs 3 & 4, and 5 & 6, respectively

Protorthoptera

(Pleconeoptera, stem group, of Kukalová-Peck & Brauckmann, 1992)

Liomopteridae

Mioloptera stuckenbergi Riek, 1973

One specimen each from Far End, Mt West and Bulwer; several from Lidgetton

Figs 7 & 8, 9 & 10, 11 & 12 respectively

***Liomoptoides similis* Riek, 1973**

Additional specimen from Bulwer

Figs 13 & 14

Liomopterina clara* Riek, 1973, synonym of *L. similis* (Riek, *in litt.*)**Mioloptoides andrei* Riek, 1976**

Additional specimens from Lidgetton

Miolopterina tenuipennis* Riek, 1976**Neoliomopterum picturatum* Riek, 1976**

Protorthoptera

(Hemineoptera, stem group, of Kukalová-Peck & Brauckmann, 1992)

Paoliidae

***Paolekia perdita* Riek, 1976**

Protelytroptera

Protocoleidae

***Phyllelytron acuminatum* Riek, 1976 (not discussed in Carpenter, 1992, absent from Africa)**

Orthoptera

Tettavidae

***Protettavus exilis* Riek, 1976 (not discussed in Carpenter, 1992)**

Locustopseidae

***Eolocustopsis primitiva* Riek, 1976 (not discussed in Carpenter, 1992)**

Homoptera

Ignotalidae Riek, 1973 (Family not recognized by Carpenter, 1992)

Ignotala mirifica* Riek, 1973**Megoniella multinerva* Riek, 1973**

One additional specimen from Balgowan

Pereboriidae?

***Perissovena heidia* Riek, 1976 (Family uncertain in Carpenter, 1992)**

Prosbolidae (as defined by Carpenter, 1992)

Genus Unknown

Fragmentary fore-wing from Bulwer

Figs 15 & 16

***Beaufortiscus dixi* Riek, 1976**Genus identity according to Carpenter, 1992, 'Probably a synonym of *Proshole*'.

Additional fore-wings and a hind-wing from Lidgetton

Figs 17 & 18

One cf. *Beaufortiscus* fore-wing from BalgowanOne cf. *Beaufortiscus* hind-wing from Balgowan

Figs 19 & 20, 21 & 22, respectively

***Neurobole ramosa* Riek, 1976**

According to Carpenter, 1992: 'Family assignment doubtful'.

***Austroprosboloides vandijki* Riek, 1973**

Transferred from Cicadoproshbolidae to Proshbolidae by Carpenter, 1992.

***Orthoscytina dubitata* Riek, 1976**

Transferred from Scytinopteridae to Proshbolidae by Carpenter, 1992.

Permocicada* Martynov, 1928**Includes *Permocicadopsis* Becker-Migdisova, 1940 (Carpenter, 1992).P. thompsoni* sp.n., fore-wing from Lidgetton**

Figs 23 & 24

species A, fore-wing from Balgowan
 species B, fore-wing and hind-wing from Balgowan
 species C, fore-wing from Balgowan
 parts of an insect including head, thorax and wings
 Figs 25 & 26, 27 & 28, 29 & 30, respectively

Stenotegmocada triclades gen. n. et sp. n.

fore-wing and hind-wing from Balgowan
 Figs 31 & 32, 33 & 34, respectively

Eoscartarellidae

Dysmorphoscartella lobata Riek, 1973 (Family uncertain: Carpenter, 1992)

Uninervidae

Redactineura acuminata Riek, 1973 (Family uncertain: Carpenter, 1992)

Ipsviciidae

Afrostenovicia reidae gen. n. et sp. n.

fore-wing from Mt West
 Figs 35 & 36

Protopsyllidiidae

Protopsyllidium lynae Riek, 1976 (not discussed in Carpenter, 1992, absent from Africa)

Blattaria

Aleuronympha bibulla Riek, 1974 (Neoptera, Order uncertain, Carpenter, 1992; removed from Homoptera)

Related specimens from Lidgetton, Mooi River, and Far End

Coleoptera

Not investigated.

Specimen from Lidgetton (Van Dijk, 1981, Fig. 75)

Two distinct specimens from Balgowan

Miomoptera

(Endoneoptera, stem group, Kukalová-Peck & Brauckmann, 1992)

Permonkidae (placed by Carpenter, 1992, in 'Neoptera - Order Uncertain')

Permonka bifida Riek, 1973

Two isolated wings, fore- and hind-, from Balgowan, close to *Permonka* (Riek, *in litt.*)

Palaeomantidae

Palaeomantis Handlirsch, 1904

P. sp.?

from Balgowan
 Figs 37 & 38

Neuroptera

Palaemerobiidae

Sismerobius pusillus Riek, 1976 (not discussed in Carpenter, 1992)

Permithonidae

Specimen from Bulwer cf. *Permithone* Tillyard, 1922
 Figs 39 & 40

Specimen from Balgowan cf. *Permopsychops* Tillyard, 1926
 Figs 41 & 42

Archeosmylidae

Specimen from Bulwer cf. *Archeosmylus* Riek, 1953
 Figs 43 & 44

Trichoptera?

Cladochoristidae

Fragment of wing from Mooi River cf. *Cladochorista* Riek, 1955
Figs 45 & 46

Mecoptera (Mecopteroid stem group of Kukalová-Peck & Willmann, 1990)

Permochoristidae

Agetochorista similis Riek, 1973 (as *Agetochoristella* Riek, 1953)

Callietheira granthami sp. n.

from Bulwer (two specimens)

Figs 47 & 48

Mesochorista channingi Riek, 1976

aff. *australica* Riek, 1976 (*Permochorista australica* Tillyard)

?Permochoristidae

Fore-wing from Balgowan

Figs 49 & 50

Mesopanorpididae

Prochoristella hartmani Riek, 1976

P. balgowanensis sp. n.

from Balgowan

Figs 51 & 52

P. bulwerensis sp. n.

from Bulwer

Figs 53 & 54

Specimen from Mt West may belong to this genus

Figs 55 & 56

Mecoptera (*sensu* Kukalova-Peck & Willmann, 1990)

Nannochoristidae

Neochoristella goodalli sp. n.

from Bulwer

Figs 57 & 58

SYSTEMATIC ACCOUNT

Megasecoptera (or Diaphanoptera?)

A wing from Mooi River (NM 885a–b), was recognised by Dr Riek as a second specimen of *Karoohymen* despite its preservation with little relief on a dark grey mudstone, with a somewhat rough surface. The wing can be estimated at 8–9 mm, which is about half the size of the holotype of *Karoohymen delicatulus*. Rs and MA appear to arise independently from R and M respectively and curve distally before meeting and fusing for a short distance before separating again. Examination of Plate I, Fig. 1 of Riek (1976) with a hand lens shows a similar configuration in *K. delicatulus*, although his drawing (Fig. 1) shows a straight cross-vein between MP forwards, to what could be interpreted either as Rs, as in Megasecoptera, or Rs+MA, as in Diaphanoptera. (cf. Figs 29.3 and 29.7, and Fig. 35.2 of Carpenter, 1992).

Odonata

A small slab, part and counterpart, from Balgowan, has a number of insect wing fragments, of which at least three overlap. Of the overlapping fragments one appears

to be the Homopteran *Ignotala*, and another is the anterior edge of an odonatan (Archizygoptera) wing, including the nodus and extending to the beginning of the terminal curvature. The odonatan remains have been assigned the number NM 2520a–b. Another small slab, part and counterpart has an odonatan specimen NM 2521a–b. It has a few costal veinlets and R-Rs cross-veins, but the presence of a subnodal cross-vein is reminiscent of the Permolestidae.

A small piece of brittle, fine-grained mudstone from Far End Quarry, adjacent to the Mooi River (National Road) site, bears what appears to be the distal part of an odonatan wing, NM 2519a–b. This resembles the corresponding region in *Polytaxineura*, suggesting assignment to the Permaeschnidae (Protanisoptera).

These fragments confirm the presence of Odonata in the Permian of Africa.

Protorthoptera

(Pleconeoptera, stem group, of Kukalová-Peck & Brauckmann, 1992)

Mioloptera is known from several specimens from Mooi River and Lidgetton, and one each at Far End, NM 2576a–b, Mt West, NM 2522a–b, and Bulwer, NM 2730a–b. *Liomopterina clara* is regarded by Dr Riek (*in litt.*) as a synonym of *Liomoptoides similis*. *Liomoptoides* is known from a more complete specimen at Bulwer, NM 2526a–b. In describing *Liomoptoides* Riek (1973: 515) remarked: 'Although this is a hind wing, it is unlikely to be the hind wing of *Mioloptera*, based on fore wings, because of the branching of Rs'. The branching of Rs in both *Mioloptera* and *Liomoptoides* is now known to be more variable than was thought, therefore this obstacle to considering *Liomoptoides* a synonym of *Mioloptera* may be less secure. The specimens from Bulwer assigned to these two genera differ considerably in size (note that the illustrations differ in scale).

Homoptera

Of the genus *Beaufortiscus*, Carpenter (1992: 217–218) commented: 'Probably a synonym of *Prosbole*.' *Prosbole* is a Permian eastern European and western Asian genus for which Carpenter gives as characteristic of the fore-wing 'R, M, and CUA dividing at about the same level.' In *Beaufortiscus* the separation of Rs from R is much more proximal than the other divisions. There is apparently in the type specimen and two other specimens, no anterior branch of the Radial seen in some or all *Prosbole*. One specimen (NM 958a–b), the proximal part of a hind-wing from the type locality of *Beaufortiscus*, shows less indentation of the costal margin than the species illustrated by Carpenter (1992, from Becker-Migdisova), and from Evans (1956); it also has a narrow medial field, whereas M is at least 4-branched in the hind-wing of *Prosbole* according to Carpenter. A hind-wing from Balgowan, NM 2536, has M with only 3 branches. The Lidgetton and Balgowan hind-wings have a similar space between M and Cu and a similar configuration of the region of the divisions of M and CuA. The only *Beaufortiscus*-like fore-wing from Balgowan, NM 2527, is not well-preserved, but resembles the type in most respects. *Beaufortiscus* at Balgowan is probably a different species. An incomplete fore-wing from Bulwer, NM 2581, differs considerably from typical *Beaufortiscus* (and *Austroprosboloides*)

and may represent a different genus. The differences include lesser curvature of M and Cu at their common origin with R, the more proximal branching of M (similar to *Austroprosoloides*), and the straighter marginal branches (cf. Van Dijk, 1997, Erratum 1998).

In a study of the Lidgetton locality, an homopteran fore-wing which differed from that of *Beaufortiscus* was illustrated (Van Dijk 1981, Fig. 58). This represents a taxon close to *Permocicada*, although the greater width of the proximal part of the *Permocicada* wing is not in evidence. The taxon, NM 982, is described below as a new species of *Permocicada*. Two incomplete homopteran fore-wings from Balgowan, NM 2542a-b and NM 2543a-b probably represent additional species of the genus. Several poorly preserved wings and a specimen with wings and body parts, NM 2546a-b, are regarded as a third species. A number of other fore-wings have been recovered from Balgowan which have in common a sloping proximal costal edge. One of these fore-wings, NM 2553, is adequate for description. Rs arises from R at about the same level as the branches of M and CuA, which differs from the *Permocicada* arrangement in which Rs arises more proximally. Accordingly NM 2553 is made the type of a new genus, *Stenotegmocicada*. A hind-wing, NM 2554, which like NM 2553 has a 3-branched M, might be the taxon's hind-wing.

A small (4 mm) elytriform tegmen from Mt West, NM 2556, has a flattened costal edge suggestive of the family Ipsviciidae. Although the posterior part of the tip of the tegmen is somewhat weathered and bleached, sufficient venational detail can be resolved to permit description of the specimen as a new genus and species, *Afrostenoviccia reidae*.

Miomoptera

(Endoneoptera, stem group, of Kukalová-Peck *et al.*, 1992)

A wing from Balgowan, NM2528a-b, shows sufficient details of venation to consider the taxon as close to *Palaeomantis*.

Neuroptera

A fragmentary wing from Mooi River was placed by Riek (1976) in the family Archeosmylidae. A specimen from Bulwer, NM 2569a-b, although only the distal half of a wing, resembles the described *Archeosmylus*, with the most noticeable difference being the lesser posterior curvature of the distal end of R.

Mecoptera

(Mecopteroid, stem group of Kukalova-Peck *et al.*, 1990)

Two wings from Bulwer, NM 2558a-b and NM 2559a-b, were identified as *Callietheira* (Permochoristidae), known from European Russia. They are here described as a new species, *Callietheira granthami*.

The genus *Prochoristella*, described for Australia, has been recorded in Africa as the species *P. hartmani* Riek, 1976 from Mooi River. One specimen from Balgowan, NM 2564a-b, and another from Bulwer, NM 2565a-b, are distinct species of this genus. Another specimen, from Mt West, NM 2566, is probably also specifically

distinct, but duplication of some of the impressions of the veins precludes an adequate description.

Mecoptera

A very small wing from Mooi River was placed by Riek (1976) provisionally in the family Nannochoristidae. A specimen from Bulwer, NM 2567a–b, is identified as *Neochorista goodalli* sp. n., of this family.

DESCRIPTIONS

Order Megasecoptera (Diaphanoptera?)

Scytohymenidae

Genus *Karoohymen* Riek, 1976

Type species: Karoohymen delicatulus Riek.

The type species was from the Mooi River site. A second, much smaller species is now known from the same locality.

***Karoohymen minutus* sp. n.**

(Figs 1 & 2)

Etymology: Refers to the very much smaller size, relative to the type species.

Type: NM 885a–b in Natal Museum.

Type locality: Mooi River.

Description. A nearly complete small wing; the length as preserved is 8 mm, indicating a total length of 9 mm; not clearly preserved except near base but showing the stems of R, MA, MP, CuA and CuP. Only basal third with venation is distinct, although distal venation is indicated. Extreme base missing. Rs 2-branched. Rs and MA fused for a very short distance. Strong branch of CuA reaches wing margin at a high angle. CuP is close to but separate from CuA over the length preserved, short, strongly curved to caudal margin.

NM 877 a–b, on same slab as holotype of *Mesochorista channingi* Riek and close to it is a fragment, partly distorted, preserving stem of R, origin of Rs, separation of Rs and MA, base of CuA and CuP to wing margin.

The species differs from *K. delicatulus* Riek not only in its very much smaller size, but also in less fusion between Rs and MA.

Taxonomic placement of the genus should be based primarily on examination of the more complete type species in the Bernard Price Institute for Palaeontological Research, University of the Witwatersrand.

Order Homoptera

Prosbolidae

Beaufortiscus dixi Riek, 1976

(Figs 19 & 20, 21 & 22)

A hind-wing from the type locality, Lidgetton, NM 958a–b, is attributed to this taxon (Figs 17 & 18). The specimen is the proximal two thirds of a hind-wing

showing the wing articulation. The front margin has a moderately deep indentation with symmetrical slopes. Basal articulation clear. Stem of Cu widely separated from stem of M; M and CuA almost parallel, separating slightly distally. Cross-vein between M and CuA shortly distal to forking on the two veins. The origins and courses of M and CuA, and the proximal position of the cross-vein between them, differ markedly from the configuration in *Prosbole*, contrary to Carpenter's (1992) suggestion that *Beaufortiscus* is probably a synonym of *Prosbole*.

Beaufortiscus sp.

A fore-wing, NM2538a-b, from Balgowan (Figs 19 & 20), is not well preserved, but appears to be similar to the type of *Beaufortiscus dixi* in those features which can be observed. The overall shape is somewhat shorter and broader than the type.

Two hind-wings, NM 2536 and NM 2537, from Balgowan, resemble NM 958a-b. NM 2536 (Figs 21 & 22) is complete except for the anal fan basal to 2A. The fore margin has a similar, moderately deep indentation at about the middle of its length. M is 3-branched. M and CuA are closer than in *Beaufortiscus dixi*, and approach one another slightly distally. NM 2537 is not well preserved.

Genus *Permocicada* Martynov, 1928

Type species: Permocicada umbrata Martynov.

This prosbolid genus with generalised wing venation has been recorded previously only from European and Asian Russia. M is 4-branched and Rs arises from R at about the middle of the wing.

***Permocicada thompsoni* sp. n.**

(Figs 23 & 24)

Etymology: Named for Mr. A. S. Thompson, of Bella Vista, Lidgetton.

Type: NM 982 in Natal Museum.

Type locality: Lidgetton.

Description. Complete fore-wing, except margin of apex, with pre-radial space and clavus closely punctate, especially basally. Fore margin thickened at base. A short, broad, slightly raised area at base of pre-radial space representing a low ventral crest, with a curved, depressed compression groove between this area and stem of R. R curves slightly forward distally. Basal cell between stems of R and CuA very wide at base, with CuA just touching R at the point of separation of M. Cross-vein between M and CuA is after the fork of M, but at (or before) the fork of CuA. Fork of MA slightly distal to fork of MP.

Specimen A cf. *Permocicada*, NM 2542a-b, from Balgowan

(Figs 25 & 26)

A fore-wing without clavus. Length 10 mm. Fork of M and cross-vein between Rs and MA in distal quarter. Division of MP not clear. Assignment to *Permocicada* is tentative in view of the incompleteness of the specimen.

Specimen B cf. *Permocicada*, NM 2543a–b, from Balgowan

(Figs 27 & 28)

A fore-wing, without clavus, NM 2543a–b, from Balgowan. Length 8 mm. Radial turns forwards distally. NM 2544, also from Balgowan, is a less clearly preserved wing. Assignment to *Permocicada* is tentative in view of the incompleteness of the specimens.

Specimen C cf. *Permocicada*, NM 2545a–b, from Balgowan

(Figs 29 & 30)

Specimen NM 2545a–b, is a fore-wing, about 6 mm long. Distinctive is the slender form of the wing. The forks of MA and MP are in the distal one-fifth. Some specimens of similar size may belong to the same taxon. They include NM 2546a–b, which has a head and thorax with a wing on either side and indications of the other wing on one side; NM 2547a–b; NM 2548; NM 2549; NM 2550; NM 2551; NM 2552.

Genus *Stenotegmocicada* gen. n.

Etymology: Refers to the narrow base of the tegmen.

Type species: *Stenotegmocicada triclades*.

Diagnosis. Fore-wing: forks of Rs from R and MP from MA, and fork of CuA branches at the same level, somewhat distal to half-way along wing. M and CuA diverge from R separately and have almost exactly parallel courses as far as the fork of MA-MP and the fork of the CuA branches. M 3-branched (MA with 2 branches). R branches close to separation of Rs.

Hind-wing: fork of Rs from R about half-way along wing, forks of MP from MP and branches of CuA at the same level more distally. M and CuA diverge from R separately and have almost exactly parallel courses to their forks. Fore margin with only a slight open emargination.

Stenotegmocicada triclades sp. n.

(Figs 31 & 32; 33 & 34)

Etymology: Refers to 3-branched M vein.

Type: Holotype NM 2553 and paratype hind wing NM 2554a–b in Natal Museum.

Type locality: Balgowan.

Description. Fore-wing: complete, including clavus. Length 6 mm. R rather strongly upturned towards apex. Distal branch of R long and regularly curved, Rs decidedly curved, subparallel to distal branch of R. CuA and M nearly parallel. MP and CuA diverge only slightly towards margin.

Hind-wing: complete except at base of anal field. Length 6 mm. M and CuA near parallel. Divergence of MA from MP, MP from CuA, and the 2 branches of CuA from one another similar and slight. This hind-wing is associated, with some reservations, with the fore-wing based on its size, only 3-branched M, and parallel course of M and CuA.

Ipsviciidae

Genus **Afrostenovicia** gen. n.

Etymology: African *Stenovicia*.

Type species: *Afrostenovicia reidae*.

Diagnosis. Structurally similar to *Stenovicia*, but wing much broader and M 3-branched. Fore margin of tegmen much more heavily thickened than in *Stenovicia*.

The wing coupling mechanism extends over entire caudal margin of clavus. The margin is not overfolded, as in Prosbolidae, but the surface is deflected just posterior to submarginal composite anal vein before a flat zone at the actual caudal margin.

***Afrostenovicia reidae* sp. n.**

(Figs 35 & 36)

Etymology: Named for Miss C. Reid.

Type: NM 2556 in Natal Museum.

Type locality: Mount West.

Description. Small (4 mm) elytriform tegmen with large clavus. Fore margin thickened, especially towards base. Surface of wing very finely rugose-punctate. R rather abruptly deflected to fore margin. Rs simple, continuing the line of stem of R, extending almost to apex. M 3-branched but branched only close to wing margin, faintly preserved. CuA 2-branched, anterior branch strongly up-arched and connected to stem of M by a long cross-vein. CuA separates only gradually from M at base, the 2 fused for some distance at base. CuP strong, straight. 1A indistinct, only slightly curved, subparallel to CuP. 2A + 3A forming a strong, straight vein close to caudal margin of clavus.

Order Miomoptera

Palaeomantidae

Genus *Palaeomantis* Handlirsch, 1904

Type species: *Palaeomantis schmidtii* Handlirsch.

Palaeomantis sp.

(Figs 37 & 38)

A fore-wing from Balgowan, NM 2528a–b, is considered close to the genus *Palaeomantis*. NM 2599a–b is a hind-wing, although rather small, which may belong to the same species.

Order Neuroptera

Permithonidae

(Figs 39 & 40, and 41 & 42)

A wing from Balgowan, NM 2568a–b, is assigned to this family, near *Permithone*.

A wing from Balgowan, NM 2570, is assigned to this family, near *Permopsychops*.

Archeosmylidae

(Figs 43 & 44)

A wing from Bulwer, NM 2569a–b, is assigned to this family, near *Archeosmylus*.

The specimen differs from the Australian *Archeosmylus* Riek in the more proximal branching and denser distal branches of Rs, and the fewer terminal branches of M.

Order Trichoptera

Cladochoristidae

(Figs 45 & 46)

A fragment of a small wing, total length estimated to have been 6–7 mm, from Mooi River, is assigned to this family, near *Cladochorista*, known from the Permian of Australia and the Triassic of the former USSR.

Order Mecoptera

Permochoristidae

Genus *Callietheira* Martynova, 1958

Type species: Callietheira khalfini Martynova.

Fore-wing: Permochoristid with Rs only 4-branched and M only 5-branched (with the extra branch on M4). Cubito-median Y-vein well developed.

***Callietheira granthami* sp. n.**

(Figs 47 & 48)

Etymology: Named for Geoffrey Grantham, geologist, who, as a child, was one of the discoverers of the Bulwer fossil site in 1959–1960.

Types: Holotype NM 2558a–b and paratype NM 2559a–b in Natal Museum, both complete fore-wings.

Type locality: Bulwer.

Description. Fore-wing: length 13 mm. Sc with first (proximal) branch distinctly oblique. Distal branch of Sc long, extending into distal quarter of wing. M5 branches from M4 close to fork of MP, in proximal half of wing. Arms of cubito-median Y-vein both well developed but the M arm somewhat shorter than the CuA arm. CuP subparallel to CuA and not deflected towards CuA at crossvein between two veins. Crossvein near wing base between CuP and 1A very oblique. 1A and 2A strong, straight, diverging slightly, crossvein close to base, very oblique and in line with cross vein between CuP and 1A. 3A distinctly forked, arms of fork long, diverging strongly and both branches directed to posterior margin. Jugal vein not preserved.

The species differs from *Callietheira* from Kaltan mainly in the more deeply forked M4.

?Permochoristidae

(Figs 49 & 50)

An imperfectly preserved wing, NM 2561, in Natal Museum, from Balgowan, characterised by a narrow costal space with no visible veinlets, and a Radial which is

almost straight (curved slightly backwards distally) with a clear fork slightly proximal to distal quarter of wing. As branching of Rs and M is unclear, identification or description is deferred until better material is available.

Mesopanorpodidae

Genus *Prochoristella* Riek, 1953

Type species: Prochoristella megaloprepia Riek.

Prochoristella balgowanensis sp. n.

(Figs 51 & 52)

Etymology: From Balgowan.

Type: NM 2564a–b in Natal Museum.

Type locality: Balgowan.

Description. Very small fore-wing, complete except for extreme base. Length 5.5 mm. Sc 2-branched, forking early, first branch almost transverse, distal branch turned towards, and reaching R (and not on costal margin) but apparently continued to form basal margin of defined pterostigma. Rs 1+2 forking well after Rs 3+4. Cubito-median Y-vein area not clear but arms of Y apparently quite equal. 2 distinct cross-veins between CuA and CuP. The three anal veins widely spaced and subparallel; 3A forked.

This species is distinguished by the unusual Sc ending on R and not on the costal margin.

***Prochoristella bulwerensis* sp. n.**

(Figs 53 & 54)

Etymology: From Bulwer.

Type: NM 2565a–b in Natal Museum.

Type locality: Bulwer.

Description. Fore-wing without anal region and posterior part of apex. Length about 5 mm. Wing with almost straight costal margin. Subcostal space narrow. Sc forking somewhat distally, distinctly after first forking of Rs, distal branch curved in middle towards R. Cross veins from Sc to R well before forking of Sc. Cubito-median Y-vein distinct but M arm very short and CuA arm very oblique. 1A well separated from CuP, other anals not preserved.

Distinguished by the distal branching of both Sc and Rs 1+2, and the small cubito-median Y-vein.

Prochoristella sp.

(Figs 55 & 56)

A small wing, 4.5 mm, from Mt West, NM 2566 in the Natal Museum, is apparently a species of *Prochoristella*, but duplication of the veins makes interpretation difficult. An apparent distinctive feature is the early forking of Sc.

Nannochoristidae

Genus *Neochoristella* Riek, 1953

Type species: Neochoristella optata Riek.

***Neochoristella goodalli* sp. n.**

(Figs 57 & 58)

Etymology: Named for the late Derek Wyatt-Goodall (who drew attention to the Bulwer site), and his family, for their active rôle in collecting.

Type: NM 2567a–b in the Natal Museum.

Type Locality: Bulwer.

Description. Fore-wing: length 3.5 mm. Complete except for part of anal field. Wing narrowing slightly to base. Fore margin slightly convex. Sc appears to curve away from costal margin before turning towards it distally. R has a distinct bend near separation of M and CuA. Rs 3-branched, all branches long. M 4-branched, branches long and more widely spaced than branches of Rs. Cubito-median Y-vein absent, with M and CuA fused for a very short distance close to base (level with bend in R). CuA distinctly curved posteriorly at (faintly preserved) cross-vein to M, cross-vein oblique and to bifurcation of M3+4. CuP in a distinct groove. 1A and 2A widely separated from one another and from CuP. 3A not preserved. A distinct cross vein between 1A and 2A.

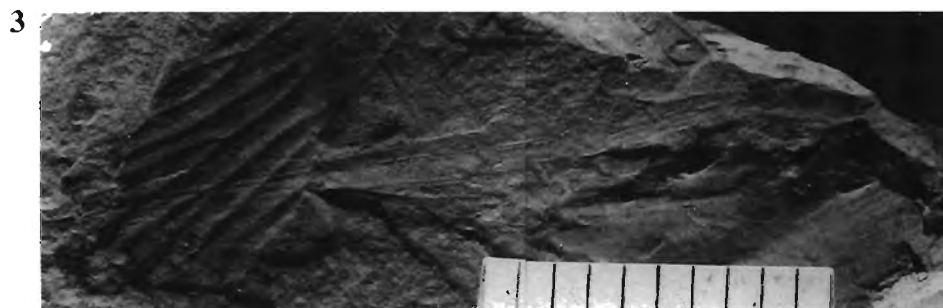
ACKNOWLEDGEMENTS

Dr Edgar Riek is acknowledged for his work on the Permian insects of KwaZulu-Natal housed in the Natal Museum; the institutions which funded him to study the Palaeozoic and Triassic insects of South Africa are also acknowledged. The Natal Museum Collection Managers, Mrs Bianca Lawrence and Mrs Allison Ruiters, have been most helpful in answering queries, locating specimens, and sending material. Many collectors helped with the collecting, and their enthusiasm is acknowledged. The comments of Dr Jarmila Kukalová-Peck on the manuscript were much appreciated.

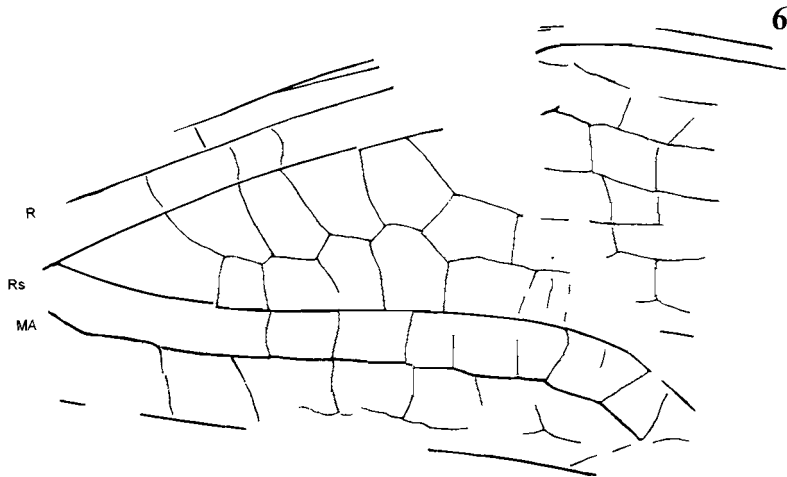
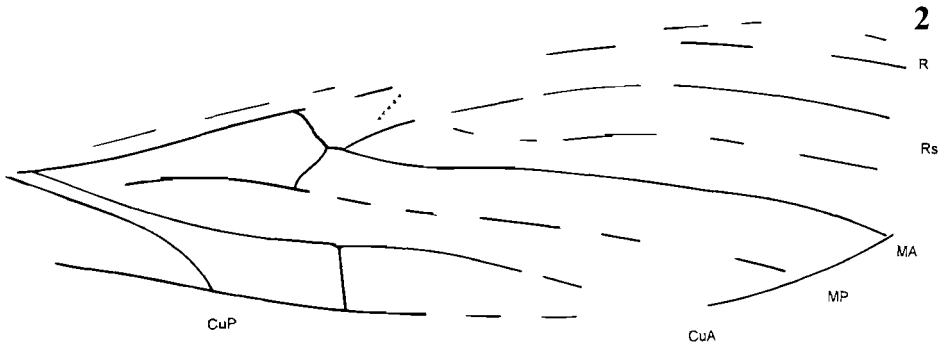
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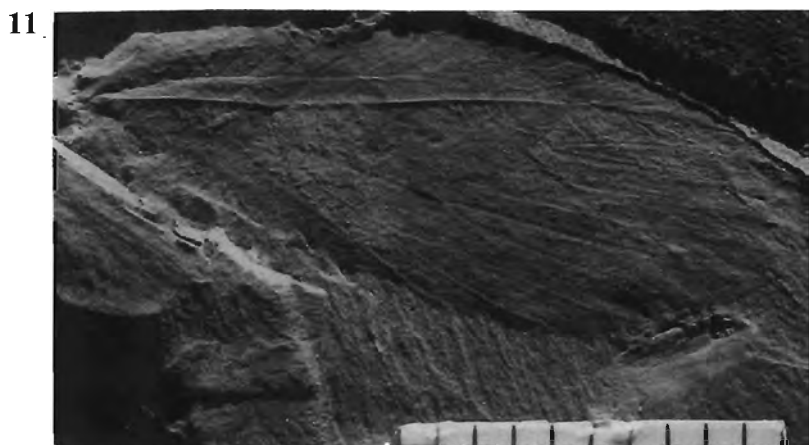
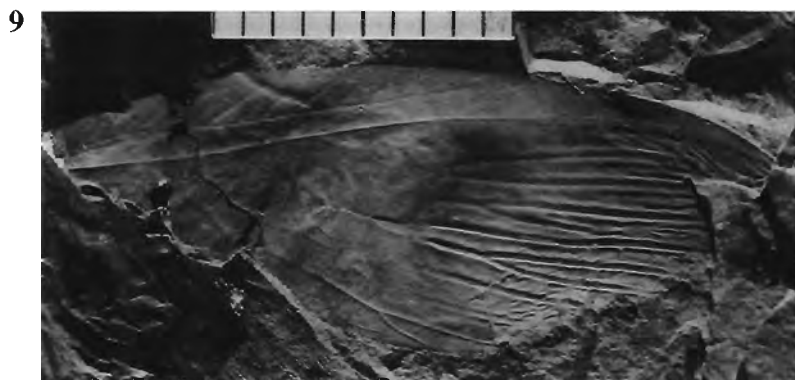
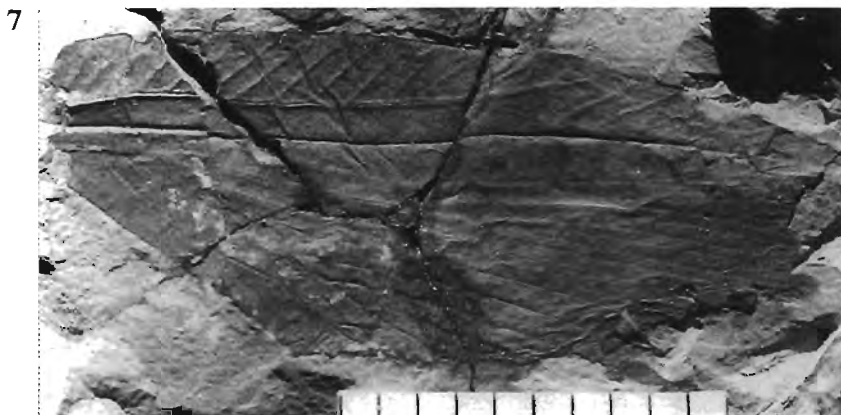
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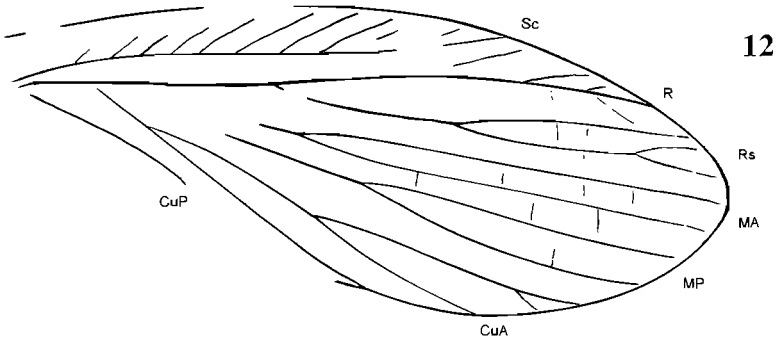
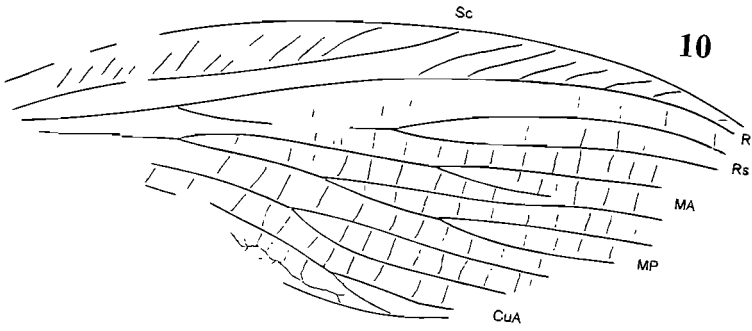
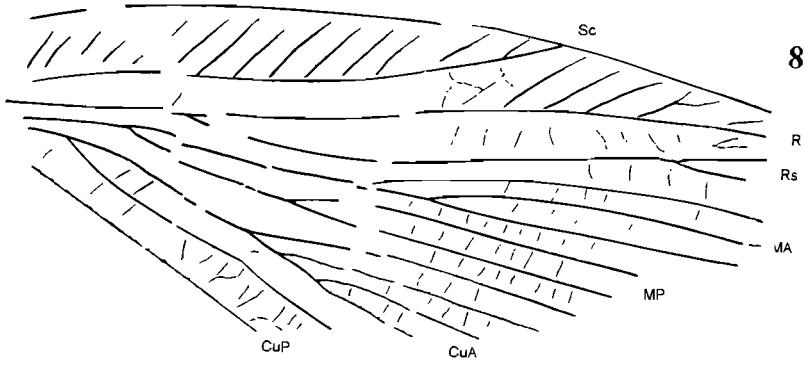


Figs 1–6. Megasecoptera and Odonata. 1–2. *Karoothymen minutus* sp. n., holotype, NM 885b, Mooi River. x 15. 3–4. Odonata cf. *Permolestidae*, NM 2520a, Balfowan, x 4. 5–6. Odonata cf. *Permaeschnidae*, NM 2519a, Far End, x10 (reversed).

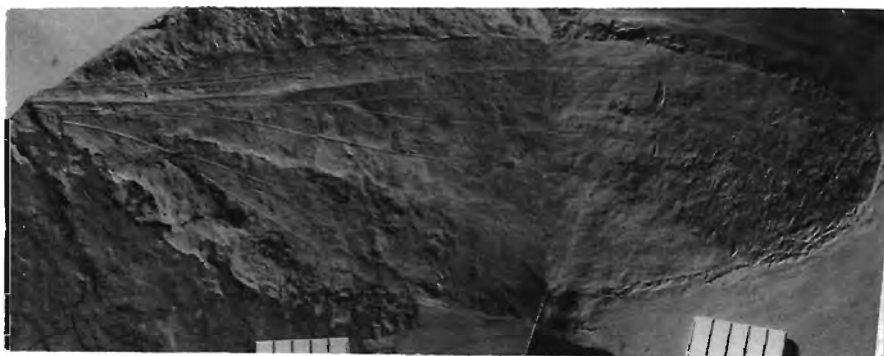




Figs 7–12. Protorthoptera. 7–8. *Mioloptera* Riek, 1973, fore-wing, NM 2576a, Far End, x 5 (reversed). 9–10. *Mioloptera* Riek, 1973, fore-wing, NM 2522a, Mount West, x 4. 11–12. *Mioloptera* Riek, 1973, fore-wing, NM 2730b, Bulwer, x 5 (reversed).



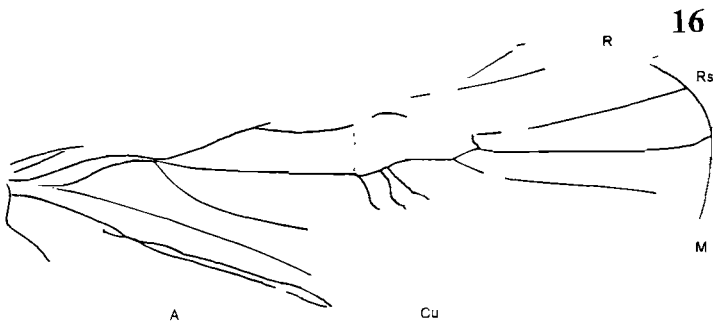
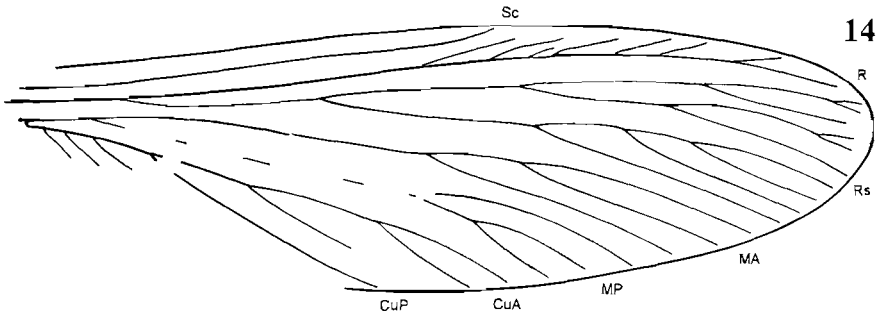
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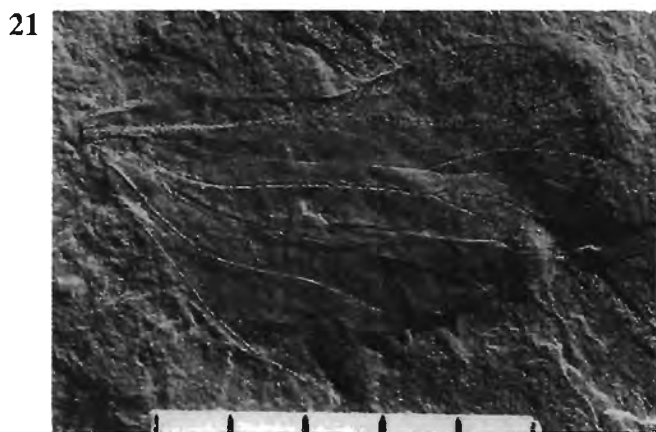


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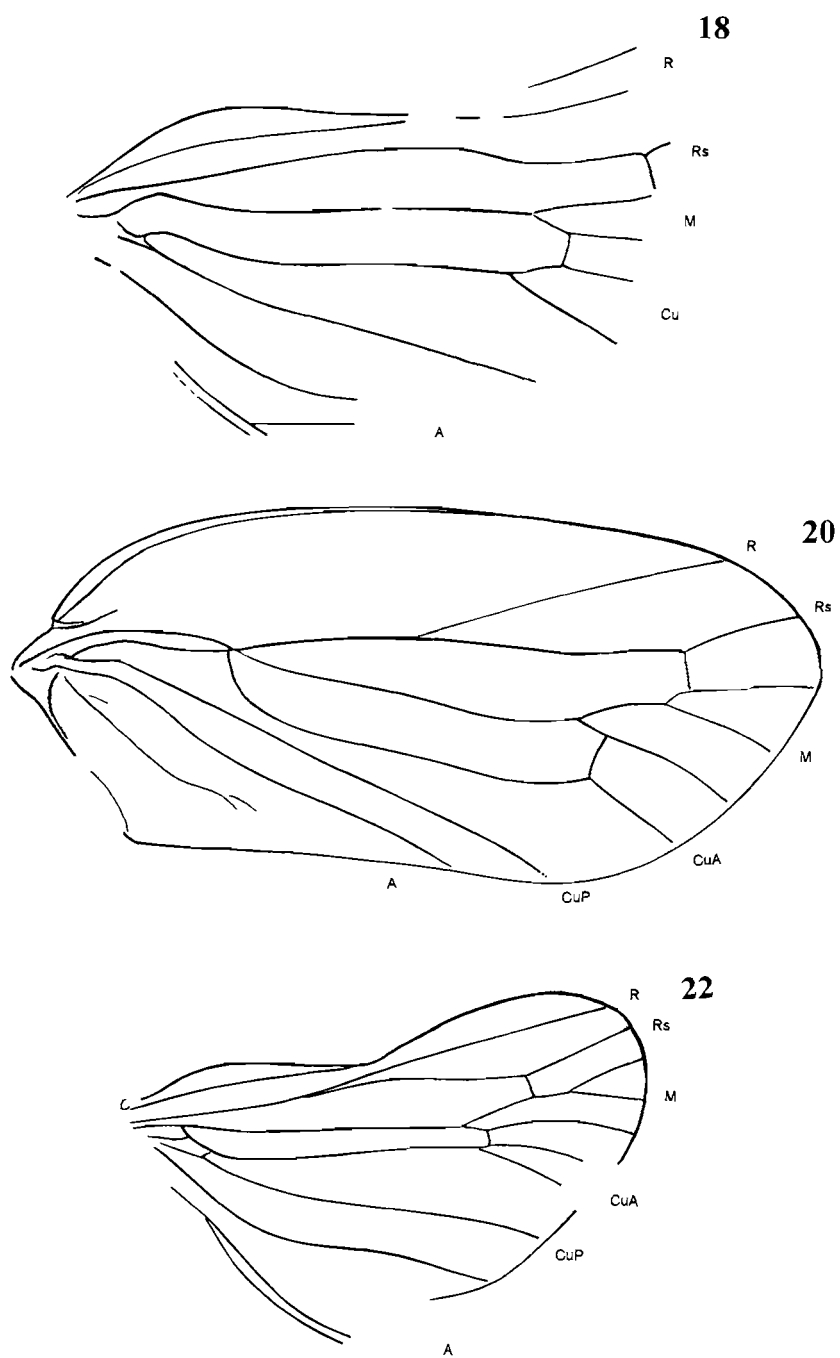


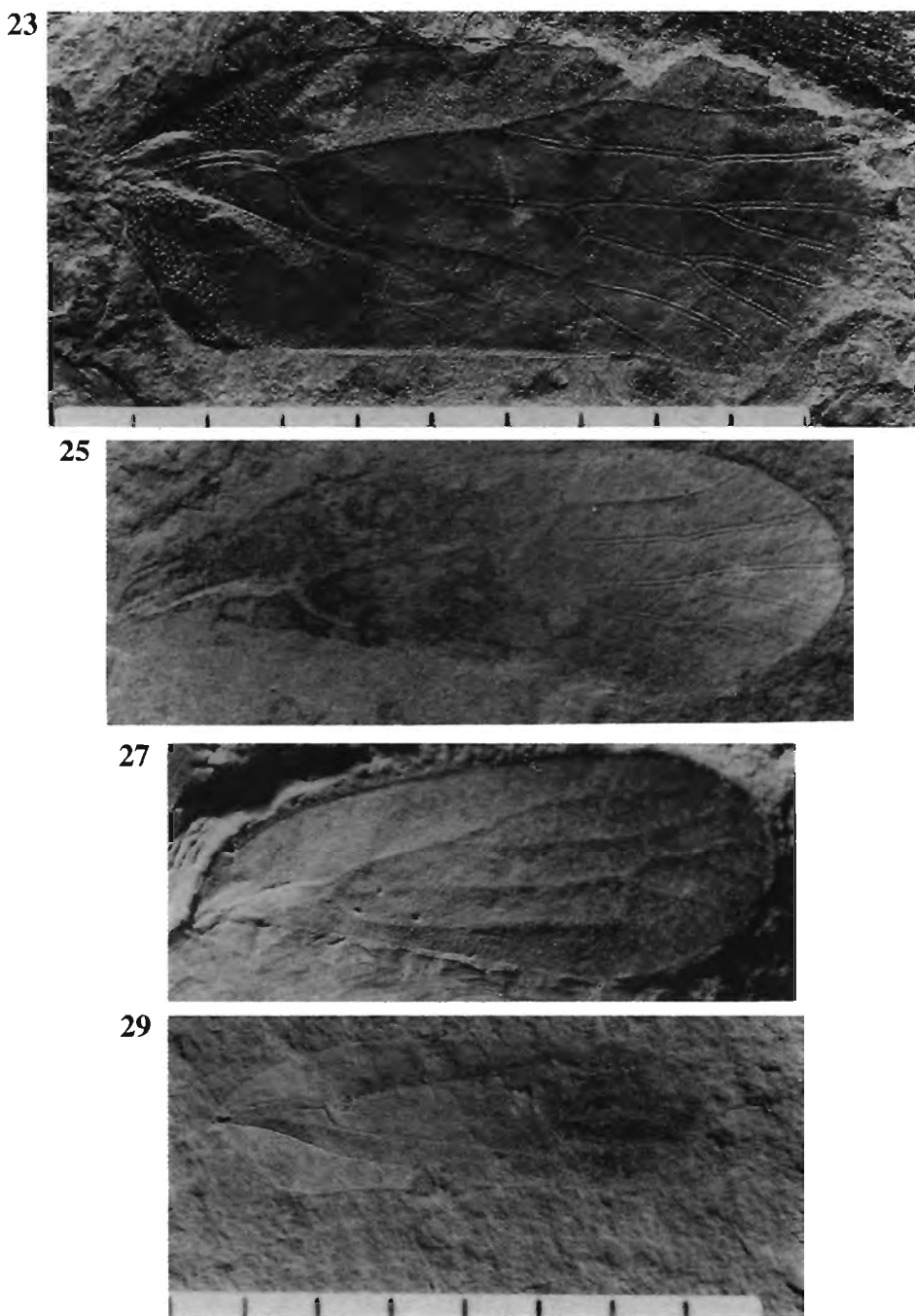
Figs 13–16. Protorthoptera and Homoptera. 13–14. *Liomoptoides* Riek, 1973, hind-wing, NM 2526a–b, Bulwer, x 2 (composite with base, NM2526a, reversed). 15–16. cf. *Beaufortiscus* Riek, 1976, fore-wing, NM 2581, Bulwer, x 6 (reversed).



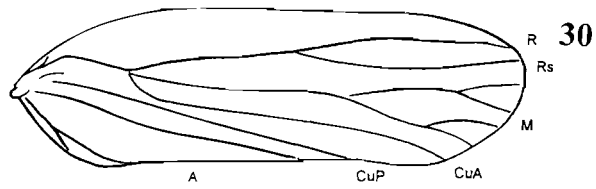
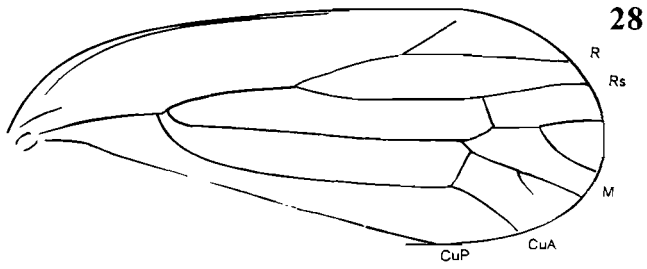
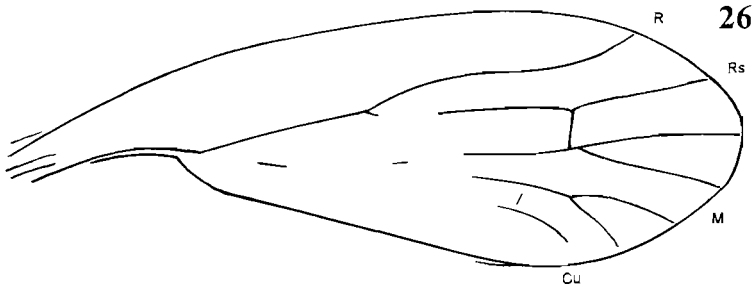
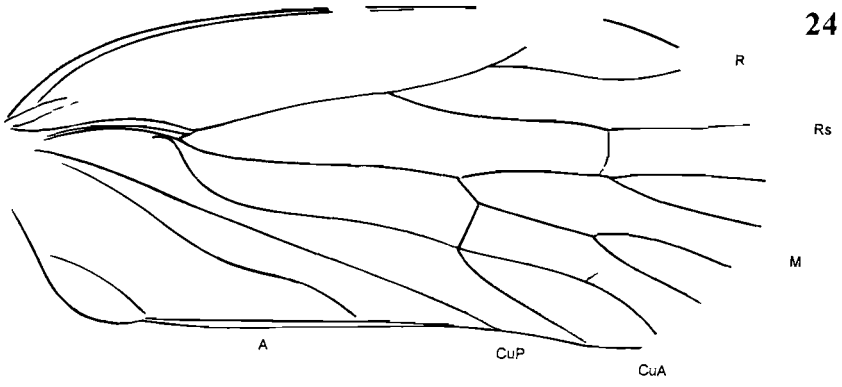


Figs 17–22. Homoptera. 17–18. *Beaufortiscus* Riek, 1976, hind-wing, NM 958a, Lidgetton, x 7 (reversed). 19–20. cf. *Beaufortiscus* Riek, 1976, fore-wing, NM 2527a, Balgowan, x 10. 21–22. cf. *Beaufortiscus* Riek 1976, hind-wing, NM 2536, Balgowan, x 10 (reversed).

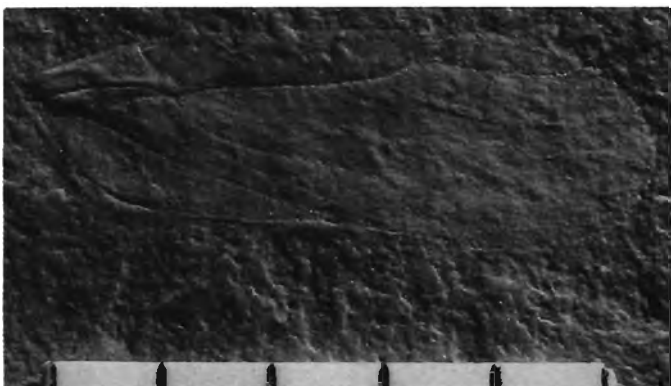




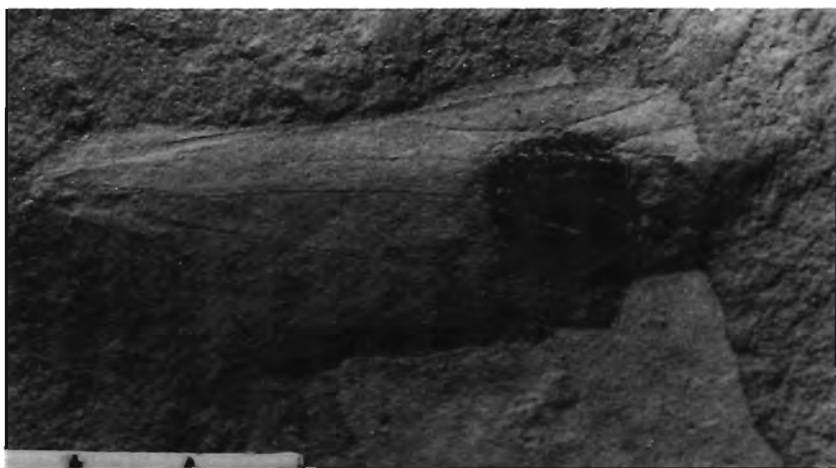
Figs 23–30. Homoptera. 23–24. *Permocicada* Martynov, 1928, *P. thompsoni* sp. n., holotype, NM 982, fore-wing, Lidgetton, x 10. 25–26. cf. *Permocicada* Martynov, 1928, sp. A, fore-wing, NM 2542a, Balgowan, x 10. 27–28. cf. *Permocicada* Martynov, 1928, sp. B, fore-wing, NM 2543a, Balgowan, x 10. 29–30. cf. *Permocicada* Martynov, 1928, sp. C, fore-wing, NM 2545a, Balgowan, x 10.



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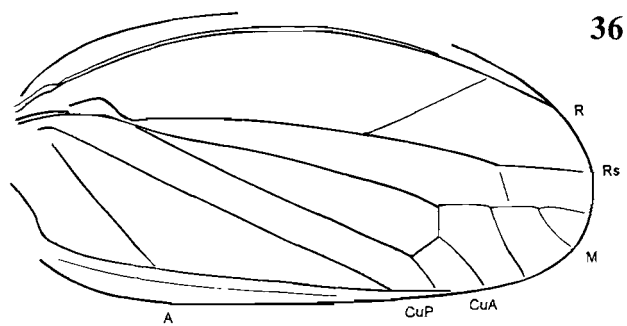
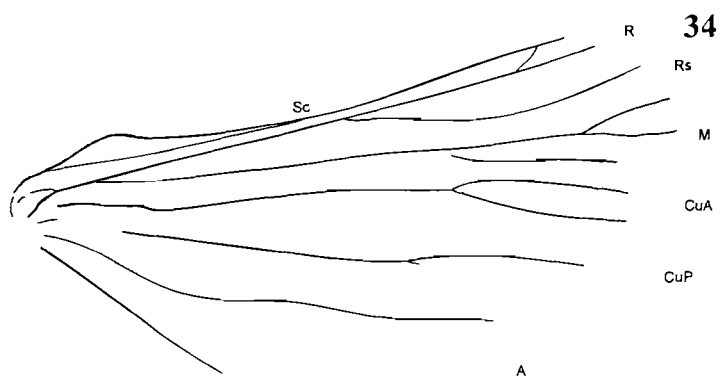
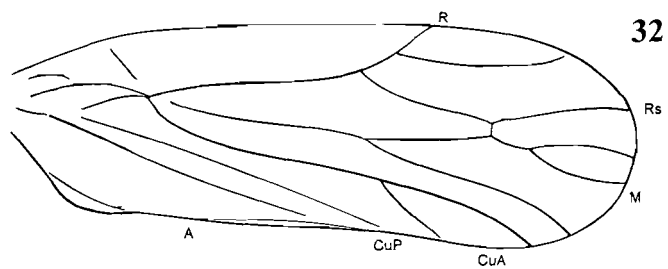
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Figs 31–36. Homoptera. 31–32. *Stenotegmoricada triclades* gen. et sp. n., holotype, NM 2553, fore-wing, Balgowan, x 15 (reversed). 33–34. *Stenotegmoricada triclades* gen. et sp. n. paratype, NM 2554a, hind-wing, Balgowan, x 15. 35–36. *Afrostenovicia reidae* gen. et sp. n., holotype, NM 2556, fore-wing, Mount West, x 22 (reversed).



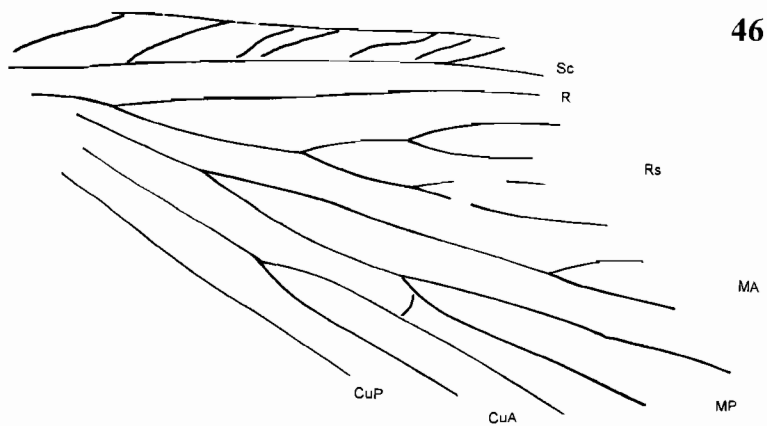
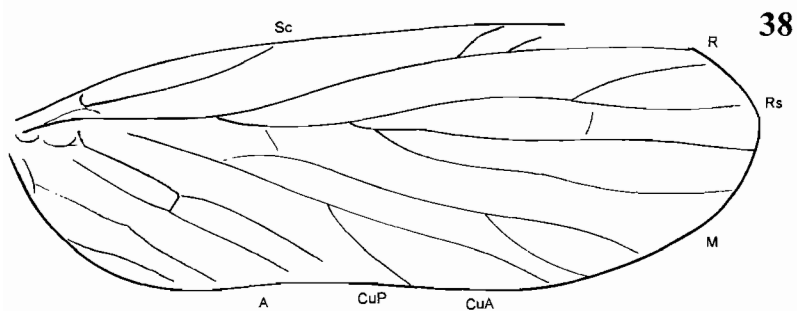
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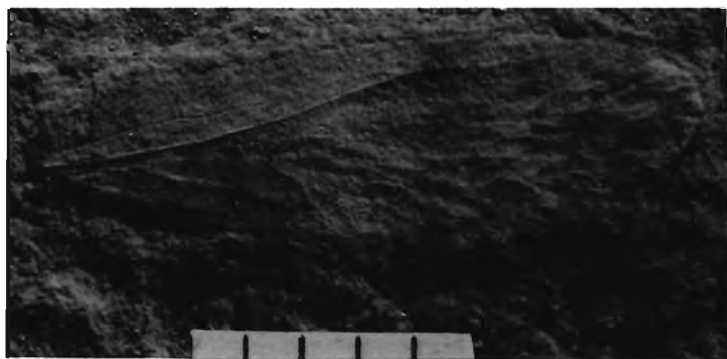
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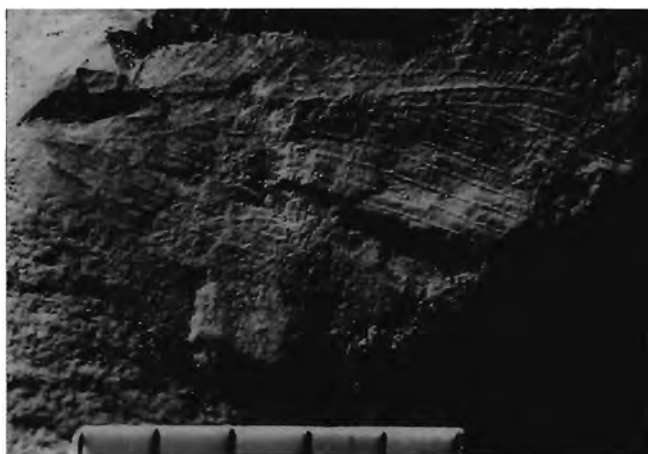
Figs 37–38 & 45–46 [Figs 39–44 on pp. 166–167] Miomoptera and Trichoptera. 37–38. cf. *Palaeomantis* Handlirsch, 1904, sp., fore-wing, NM 2528b, Balgowan, x 15 (reversed). 45–46. cf. *Cladochorista* Riek, 1955, NM 2700a, Mooi River, x 25 (reversed NM 2700b included in Fig. 46).



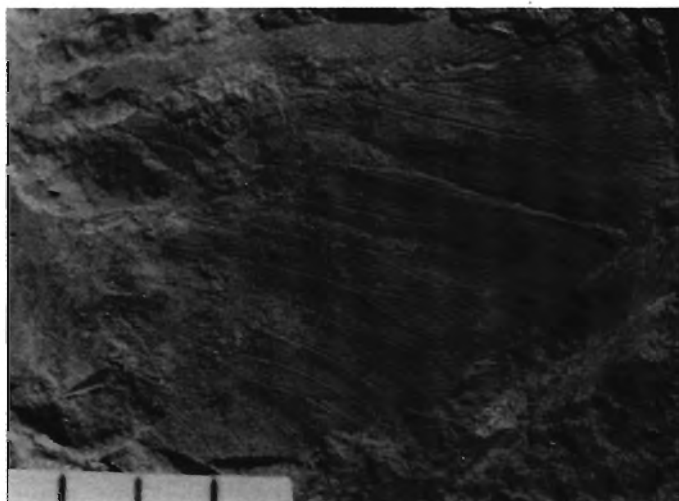
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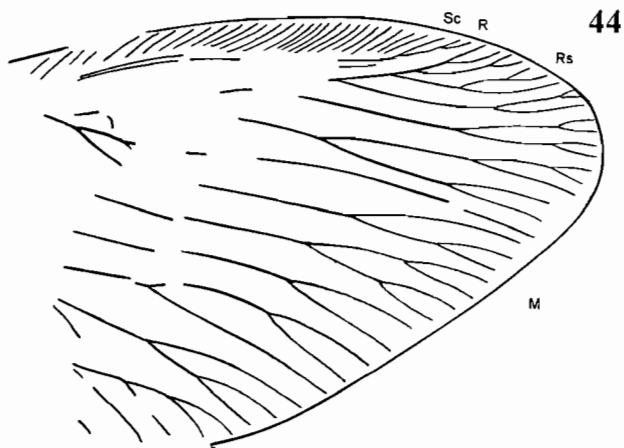
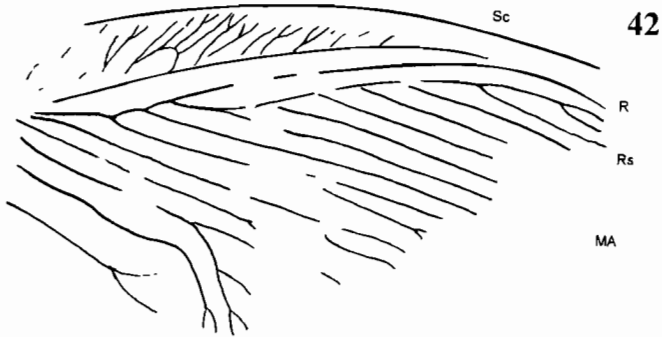
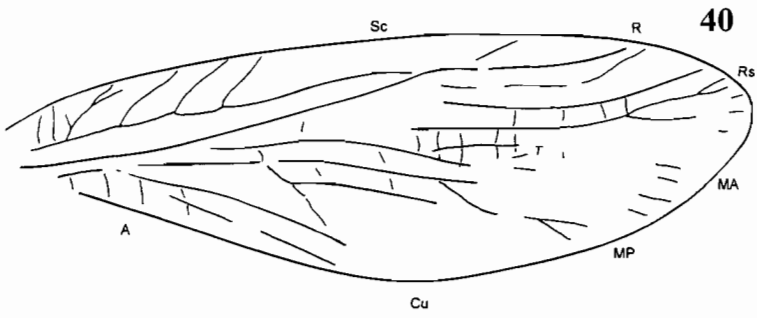
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Figs 39–44. Neuroptera. 39–40. cf. *Permithone* Tillyard, 1922, NM 2568a, Balgowan, x7 (reversed). 41–42. cf. *Permopsychops* Tillyard, 1926, NM 2570, Balgowan, x 10. 43–44. cf. *Archeosmylus* Riek, 1953, NM 2569a, Bulwer, x 10 (reversed).



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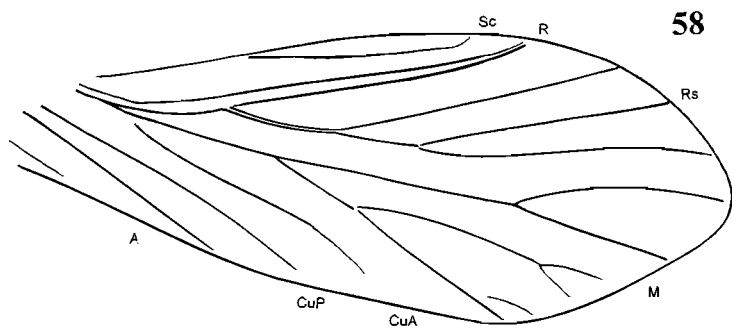
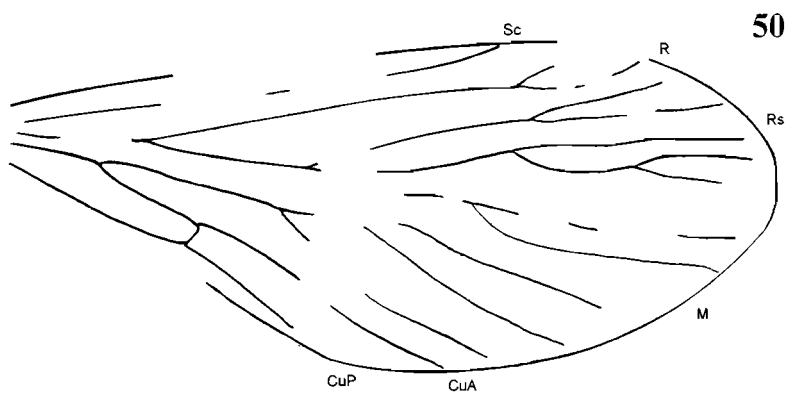
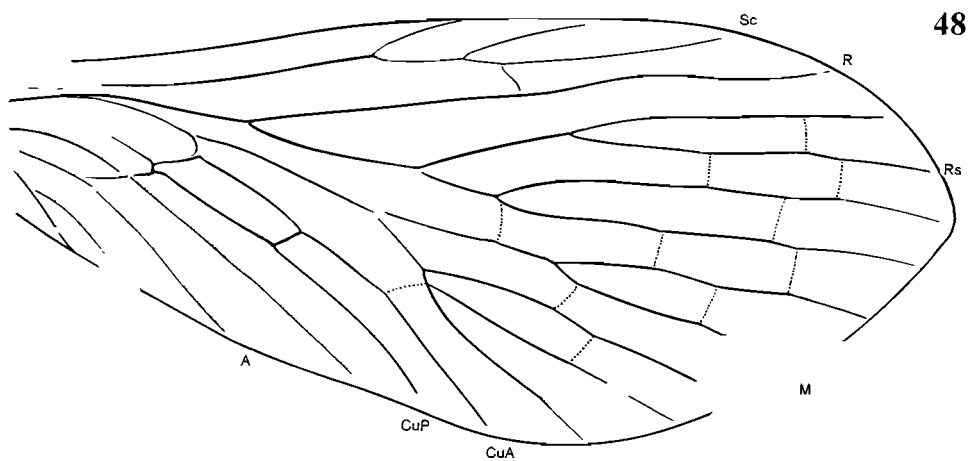
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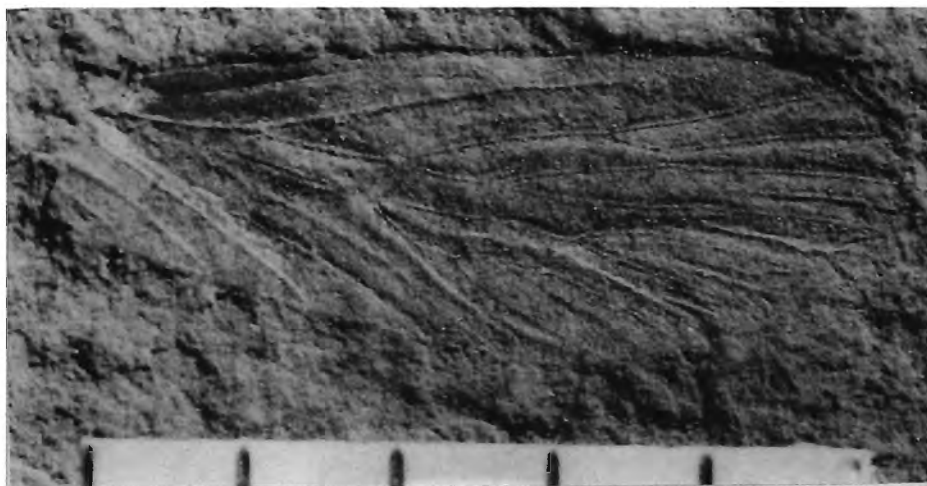
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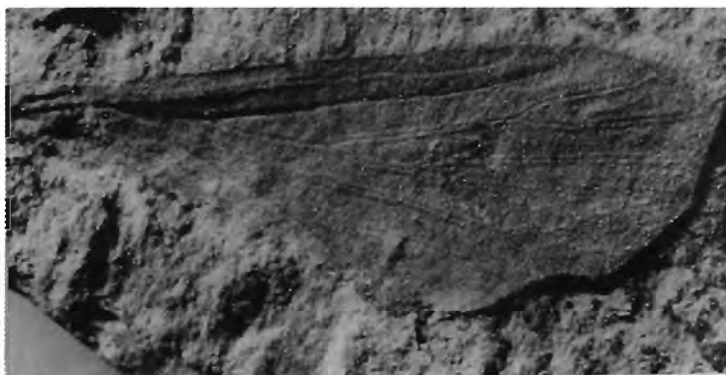
Figs 47–50 & 57–58 [Figs 51–56 on pp. 170–171]. Mecoptera. 47–48. *Callietheira* Martynova, 1958, *C. granthami* sp. n., holotype, NM 2558a, fore-wing, Bulwer, x 10 (reversed). 49–50. ?*Permochoristidae*, NM 2561, Balgowan, x 16. 57–58. *Neochoristella* Riek, 1953, *N. goodalli* sp. n. holotype, NM 2567a, fore-wing, Bulwer, x 30. (Note: The specimen which has the correct relief, had to be lit from behind, giving the incorrect relief).



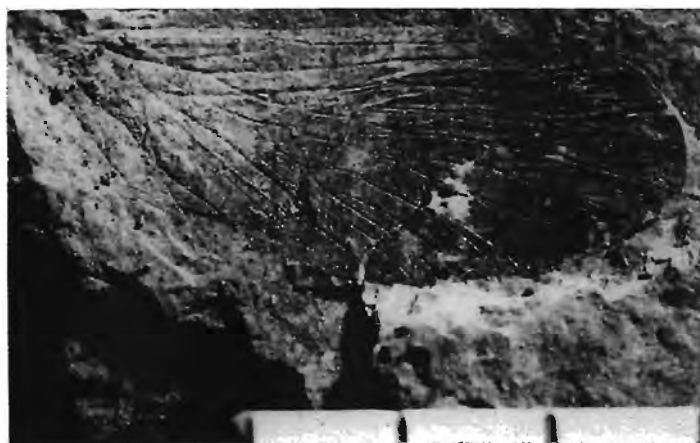
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Figs 51–56. Mecoptera. 51–52. *Prochoristella* Riek, 1953, *P. balgowanensis* sp. n. holotype, fore-wing, NM 2564a, Balgowan, x 20 (reversed). 53–54. *Prochoristella* Riek, 1953, *P. bulwerensis* sp. n. holotype, NM 2565a, fore-wing, Bulwer, x 20. 55–56. *Prochoristella* Riek, 1953, sp. n. holotype, NM 2566, fore-wing, Mount West, x 20 (reversed).

